Gas Laws

STP = Standard temperature + pressure

$0°C = 273K$ ($°C + 273$) all gas laws use Kelvin

1 ATM 101.3 KPa 760 mmHg

Boyle's Law

↑P ↓V ↓P ↑V

$V_1P_1 = V_2P_2$

Charles' Law

↑T ↑V ↓T ↓V

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

Combined Gas Law

$$\frac{V_1P_1}{T_1} = \frac{V_2P_2}{T_2}$$

ALL Temps in KELVIN

Boyle's Law Practice

#1
$V_1 = 100.0 cm^3$
$P_1 = 10.50 KPa$
$V_2 = ?$
$P_2 = 9.91 KPa$ (3sf)

$$\frac{(100.0 cm^3)(10.50 KPa)}{9.91 KPa} = \frac{V_2 (9.91 KPa)}{9.91 KPa}$$

$V_2 = 106 cm^3$

Charles's Law Practice

3. $V_1 = 0.560L$
   $T_1 = \cancel{120°C} \rightarrow 393K$
   $V_2 = 0.400L$
   $T_2 = ?$

$\frac{V_1}{T_1} = \frac{V_2}{T_2}$

$\frac{0.560L}{393K} = \frac{0.400L}{T_2}$

$T_2 = \boxed{281\,K}$

Combined Gas Laws Practice

1. $V_1 = 500.0ml$
2 sf $P_1 = 120\,kPa$
   $T_1 = 293K$
   $V_2 = ?$
   $P_2 = 101.3\,kPa$
   $T_2 = 273K$

$\frac{(500.0ml)(120kPa)}{293K} = \frac{V_2(101.3kPa)}{273K}$

$V_2 = \boxed{550ml}$

$(500 \cdot 120 \cdot 273) \div (293 \cdot 101.3)$

$551.8 \rightarrow 550$

STP 0°C 273K 1 ATM 101.3 kPa 760 mmHg

Boyle's Law
$V_1P_1 = V_2P_2$
(inverse)

Charles Law
$\frac{V_1}{T_1} = \frac{V_2}{T_2}$
(Direct)

Combined Gas Laws
$\frac{V_1P_1}{T_1} = \frac{V_2P_2}{T_2}$

$PV = nRT$ (n = moles)

$PVm = gRT$ (m = molar mass, g = grams given)

R values (Ideal Law Gas Constant)

$0.0821 \frac{L \cdot atm}{mol \cdot K}$ $8.31 \frac{L \cdot kPa}{mol \cdot K}$ $62.4 \frac{L \cdot mmHg}{mol \cdot K}$

Calculating the density of a gas:

$D = \frac{m}{V}$ $D_{STP} = \frac{\text{molar mass}}{22.4L}$ (gas only)

CO_2 $?D_{STP} = \frac{44.01g}{22.4L} = \boxed{1.969/L}$

O_2 $?D_{STP} = \frac{32.00g}{22.4L} = \boxed{1.439/L}$

if NOT at STP use combined gas Law to find volume.

12. units ml (V) & mmHg (P) $V_1P_1 = V_2P_2$

Start: $V_1 = 380$ ml, $P_1 = 800$ mmHg

End: $V_2 = ?$, $P_2 = 760$ mmHg

$(380\text{ml})(800\text{mmHg}) = (V_2)(760\text{mmHg})$

$V_2 = \boxed{400\text{ ml}}$

14. V & P

$V_1 = 240.0$ ml

$P_1 = 70.0$ cmHg

$V_2 = 60.0$ ml

$P_2 = ?$

$(240.0\text{ml})(70.0\text{cmHg}) = (60.0\text{ml})(?\text{cmHg})$

$P_2 = \boxed{280.\text{ cmHg}}$

16. V & T * change °C → K

$V_1 = 90.0$ ml

$T_1 = 300.$ K

$V_2 = ?$

$T_2 = 315.$ K

$\frac{90.0\text{ml}}{300.\text{K}} = \frac{V_2}{315\text{K}}$

$V_2 = \boxed{94.5\text{ ml}}$

START
$V_1 = 380\ ml$
$P_1 = 800\ mmHg$
$T_1 = none\ given$

END
$V_2 = ??$
$P_2 = 760\ mmHg$
$T_2 = none\ given$

(12.) $V_1P_1 = V_2P_2$ Boyle's Law

$(380ml)(800mmHg) = (V_2)(760mmHg)$

$$\frac{(380ml)(800\cancel{mmHg})}{760\cancel{mmHg}} = V_2$$

$$\boxed{V_2 = 400\ ml}$$

$V_1 = 240.0\ ml$
$P_1 = 70.0\ cm$
$T_1 = Not\ given$
$V_2 = 60.0\ ml$
$P_2 = ?$
$T_2 = Not\ given$

(14) $(240.0ml)(70.0cm) = (60.0ml)(P_2)$

$$\frac{(240.0\cancel{ml})(70.0cm)}{60.0\cancel{ml}} = \boxed{280.\ cm}$$

$V_1 = 90.0\ ml$
$P_1 = not\ given$
$T_1 = 300\ K$
$V_2 = ??$
$P_2 = not\ given$
$T_2 = 315\ K$

(16) $\frac{90.0ml}{300K} = \frac{V_2}{315K}$

$$\frac{(90.0ml)(315K)}{300\ K} = \boxed{\cancel{94.5}\ ml}$$

95 ml

12.

$V_1 = 380\ ml$

$P_1 = 800\ mmHg$

~~$T_1 =$~~

$V_2 = ?$

$P_2 = 760\ mmHg$

~~$T_2 =$~~

$V_1P_1 = V_2P_2$

$(380ml)(800mmHg) = (V_2)(760mmHg)$

$$\frac{(380ml)(800\cancel{mmHg})}{760\cancel{mmHg}} = V_2$$

$$\boxed{V_2 = 400\ mmHg}$$

14.

$V_1 = 240.0ml$ $V_2 = 60.0ml$

$P_1 = 70.0cm$ $P_2 = ??$

~~$T_1 =$~~ ~~$T_2 =$~~

$V_1P_1 = V_2P_2$

$(240.0ml)(70.0cm) = (60.0ml)(P_2)$

$$\frac{(240.0ml)(70.0cm)}{60.0ml} = P_2$$

$$\boxed{P_2 = 280.\ cm}$$

16. $V_1 = 90.0ml$ $V_2 = ?$

~~$P_1 =$~~ ~~$P_2 =$~~

$T_1 = 300K$ $T_2 = 315K$

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

$$\frac{90.0ml}{300K} = \frac{V_2}{315K}$$

$$\frac{(90.0ml)(315K)}{300K} = V_2$$

$$\boxed{V_2 = 95\ ml}$$